

**MOTORCYCLE HAVING JACK SHAFT TO**  
**ACCOMMODATE WIDE REAR TIRE**

**Background of the Invention**

**Field of the Invention**

The present invention relates generally to motorcycles, and more particularly, to a motorcycle having an intermediate shaft between the transmission power take-off and the rear wheel.

**Description of the Relevant Art**

Motorcycles have been used for transportation for many years and are still popular today. A particular segment of the motorcycle market consists of high-performance motorcycles having relatively large and powerful engines. Perhaps the most well-known manufacturer of such high performance motorcycles is the Harley Davidson Company of Milwaukee, Wisconsin. Prior art motorcycles typically include a motor and a transmission. The motor crankshaft is coupled to the input of the transmission by a chain or belt drive. The output, or power take-off, of the transmission is then coupled by a second chain or belt drive directly to a sprocket on the rear wheel of the motorcycle.

Motorcycles with wider rear tires, like those installed on cars, have become very popular. However, a rear wheel using a wide tire necessarily displaces the drive gear or sprocket laterally apart from the centerline of the motorcycle frame. In turn, the drive belt or chain that extends between the transmission power take-off and the rear wheel must also be displaced off to the side, away from the centerline of the motorcycle frame, to pass around the wider tire. Manufacturers have been dealing with this problem by shifting the motor and transmission further away from the centerline of the frame, thereby keeping the power take-off of the transmission and the sprocket of the rear wheel in approximately the same plane. However, this practice shifts the center of mass of the motorcycle away from the centerline of the motorcycle frame, and tends to make the bike unbalanced and harder to control.

Accordingly, it is an object of the present invention to provide a motorcycle which accommodates wide rear tires without the need to shift the center of mass of the motorcycle away

1 from the centerline of the motorcycle frame.

2 It is another object of the present invention to provide such a motorcycle which  
3 effectively eliminates the need to laterally displace the motor or transmission in order to  
4 accommodate a wide rear tire.

5 It is a further object of the present invention to provide such a motorcycle which  
6 accommodates a wide rear tire without impairing the handling or balance of the motorcycle.

7 A still further object of the present invention is to allow a motorcycle to incorporate a  
8 wide rear tire whether the motorcycle includes a so-called soft tail rear suspension or a rigid tail.

9 These and other objects of the present invention will become more apparent to those  
10 skilled in the art as the description of the present invention proceeds.

11

#### 12 Summary of the Invention

13 Briefly described, and in accordance with the preferred embodiment thereof, the present  
14 invention relates to a motorcycle having a transmission system that accommodates an enlarged  
15 rear tire through the use of an intermediate shaft, or "jack shaft". The motorcycle includes a  
16 conventional support frame for supporting a rider, an engine and a transmission mounted to such  
17 frame, and a rear wheel rotatably coupled to the rear end of the support frame. The rear wheel  
18 includes a conventional drive gear or sprocket for applying torque to the rear wheel; this rear  
19 wheel drive gear extends within a first vertical plane that is laterally spaced apart from the  
20 longitudinal axis of the support frame by a first offset distance. The engine mounted generates a  
21 turning force to propel the motorcycle, and the transmission is coupled to the engine for  
22 selectively coupling the turning force generated by the engine to a transmission output gear or  
23 power take-off.

24 In the present invention, the transmission output gear extends substantially within a  
25 second vertical plane spaced apart from the longitudinal axis of the support frame by a second  
26 offset distance, but wherein the second offset distance is significantly smaller than the first offset  
27 distance. In other words, the power take-off gear of the transmission is significantly closer to the  
28 central longitudinal axis of the support frame than is the rear wheel drive gear. To account for

1 the lateral spacing difference between the power take-off gear and the rear wheel drive gear, an  
 2 intermediate shaft is rotatably secured to the support frame as by a bearing assembly, the  
 3 intermediate shaft including a power input gear extending substantially within the same vertical  
 4 plane as the power take-off gear. The intermediate shaft also includes a power output gear that  
 5 rotates together with the power input gear, but the power output gear extends substantially within  
 6 the same vertical plane as does the rear drive gear. A first drive belt is engaged with, and extends  
 7 between, the transmission output gear and the power input gear of the intermediate shaft. A  
 8 second drive belt is engaged with, and extends between, the power output gear of the  
 9 intermediate shaft and the rear wheel drive gear.

10 In one embodiment of the present invention, the first and second drive belts are first and  
 11 second chains, respectively. In this embodiment, the transmission output gear and power input  
 12 gear are sprockets that engage the first chain; the power output gear and rear wheel drive gear are  
 13 also sprockets, and each engages the second chain. Alternatively, the first and second drive belts  
 14 can be in the form of flexible belts each having a toothed inner surface; in this embodiment, the  
 15 transmission output gear and power input gear are toothed drive belt pulleys that engage the first  
 16 toothed drive belt, and the power output gear and rear wheel drive gear are also toothed drive belt  
 17 pulleys that engage the second toothed drive belt.

18 The intermediate shaft allows the first and second drive belts to extend within spaced  
 19 vertical planes, hence allowing the transmission output gear and the rear wheel drive gear to  
 20 extend within such laterally spaced planes. Accordingly, there is no need to displace the center  
 21 of mass of either the engine or the transmission away from the longitudinal axis of the support  
 22 frame, thereby improving the handling and balance of the motorcycle.

23 As mentioned above, the present invention may be used with both motorcycles having  
 24 soft-tail suspensions, as well as those having rigid rear suspensions. In motorcycle frames  
 25 having a soft-tail suspension, the support frame includes a tail frame portion for supporting the  
 26 rear wheel, wherein the tail frame portion rotatably supports the rear wheel, and is itself pivotally  
 27 secured to the support frame about a tail pivot axis. The present invention may advantageously  
 28 be incorporated within such a soft-tail suspension motorcycle by rotatably securing the

1 intermediate shaft to the support frame about a rotational axis that is coincident with the tail  
2 pivot axis.

#### 4 Brief Description of the Drawings

5 Fig. 1 is a side view of a motorcycle including an intermediate shaft, and including first  
6 and second drive belts in accordance with the present invention.

7 Fig. 2 is a close-up, partially cut-away, perspective view of the rear end of the motorcycle  
8 shown in Fig. 1.

9 Fig. 3 is an enlarged rear view of the intermediate shaft and the tail portion of a soft-tail  
10 suspension support frame as shown in Fig. 1.

11 Fig. 4 is an exploded perspective view of the intermediate shaft, as well as a bearing  
12 assembly used to rotatably secure the intermediate shaft to the motorcycle support frame.

13 Fig. 5 is an enlarged perspective view of the intermediate shaft.

14 Fig. 6 is an enlarged perspective view of an alternate embodiment of the intermediate  
15 shaft adapted to engage a pair of toothed rubber drive belts.

16 Fig. 7 is a plan view of an alternate embodiment of the present invention using toothed  
17 drive pulleys and toothed rubber drive belts.

#### 19 Detailed Description of the Preferred Embodiment

20 A motorcycle incorporating the present invention is designated generally by reference  
21 numeral 20 in Fig. 1. Motorcycle 20 includes a front wheel 22 supported by a front fork 24, a  
22 central tubular support frame 26, a rear wheel 28, and a soft tail suspension, or swing arm frame,  
23 30 for pivotally securing rear wheel 28 to central support frame 26. Central support frame may  
24 be constructed from tubular frame members formed of aircraft billet aluminum tubing of the type  
25 designated .188 Wall Dom T6 6061 aircraft billet aluminum tubing. Rear wheel 38 is, of course,  
26 supported by suspension frame 30 in a manner which permits rear wheel 28 to rotate. Seat 32 is  
27 secured to the upper portion of central support frame 26 for supporting a rider. It will be noted  
28 that central support frame 26 extends along a longitudinal axis from its front end (near front

1 wheel 22) to its rear end (near rear wheel 28). Central support frame 26 also supports a motor 34  
2 for generating a turning force to propel the motorcycle, and a transmission 36 coupled to motor  
3 34 for selectively coupling the turning force generated by motor 34 to a transmission output gear  
4 (not shown), in the usual manner.

5 Rear wheel 28 includes a rear wheel drive gear, or sprocket, 38 for applying torque to the  
6 rear wheel. Ordinarily, a chain or belt would extend between the transmission output gear (not  
7 shown) of transmission 36 and rear wheel drive gear 38 to directly couple the two together.  
8 However, as described above, the use of a relatively wide rear tire 28 forces rear wheel drive gear  
9 38 to be disposed further away from the central longitudinal axis of central support frame 26.  
10 Others have, in the past, shifted motor 34 and transmission 36 in the same lateral direction to  
11 maintain the transmission output gear (not shown) in the same relative vertical plane as rear  
12 wheel drive gear 38. As indicated above, however, this practice tends to make the motorcycle  
13 unbalanced by shifting weight away from the central axis of the motorcycle.

14 In practicing the present invention, an intermediate shaft assembly, or "jack shaft" 40, is  
15 interposed between transmission 36 and rear wheel drive gear 38 in order to permit rear wheel  
16 drive gear 38 to extend further away, in the lateral direction, from the central longitudinal axis of  
17 support frame 26. As shown best in Figs. 2-5, intermediate shaft 40 includes a hollow central  
18 cylinder 42 having a power input gear, or sprocket, 44 and a power output gear, or sprocket, 46  
19 extending from opposing ends thereof. Intermediate shaft 40 is rotatably secured to the central  
20 support frame 26, and a pair of bearing races 48 and 50 are inserted into the hollows of power  
21 input gear 44 and power output gear 46, respectively, for such purpose. As indicated in Fig. 5,  
22 bearing races 48 and 50 are engaged by roller bearing assemblies 52 and 54 to permit  
23 intermediate shaft 40 to freely rotate relative to central support frame 26. Internal spacer tube 53  
24 extends inside the hollow of intermediate shaft 40 and maintains proper spacing between the two  
25 roller bearing assemblies 52 and 54. Also shown in Fig. 4 is an end spacer 55 which pushes  
26 against roller bearing assembly 52, and which spaces the end of intermediate shaft 40 apart from  
27 central support frame 26.

28 Power output gear 46 of intermediate shaft 40 extends substantially within the same

1 vertical plane as does rear wheel drive gear 38. Within the embodiment illustrated in Figs. 1-5, a  
2 drive chain 56 is engaged over both power output gear 46 and rear wheel drive gear 38. Thus,  
3 power output gear 46, rear wheel drive gear 38, and drive chain 56 all extend substantially within  
4 a first vertical plane that is a first offset distance from the central longitudinal axis of central  
5 support frame 26.

6 While the transmission output gear of transmission 36 is hidden from view in the  
7 accompanying patent drawings, the transmission output gear extends substantially within the  
8 same vertical plane as does power input gear 44 of intermediate shaft 40. This vertical plane is a  
9 second offset distance away from the central longitudinal axis of central support frame 26. Drive  
10 chain 58 is engaged over both the transmission output gear (not shown) and power input gear 44  
11 of intermediate shaft 40. Thus, the transmission output gear, drive chain 58, and power input  
12 gear 44 all lie substantially within the second vertical plane that is laterally spaced from the  
13 central longitudinal axis of central support frame 26 by the aforementioned second offset  
14 distance. This second offset distance is smaller than the aforementioned first offset distance. By  
15 varying the length of intermediate shaft 40, and hence, the distance between power input gear 44  
16 and power output gear 46, a motorcycle manufacturer can easily account for rear tires of various  
17 widths. The applicant has found that a separation distance of from two-four inches between  
18 power input gear 44 and power output gear 46 is usually sufficient to accommodate wider rear  
19 tires typically being installed on motorcycles today.

20 In the embodiment of the present invention described thus far relative to Figs. 1-5,  
21 sprocket gears are engaged by chains to transmit torque from transmission 36 to rear wheel 28.  
22 However, those skilled in the art will appreciate that drive chains 56 and 58 may be replaced by  
23 flexible rubber drive belts. For example, suitable power transmission drive belts may be  
24 obtained from The Gates Rubber Company of Denver, Colorado under the brand name "POLY  
25 CHAIN". These drive belts have a toothed inner surface adapted to be engaged by toothed drive  
26 pulleys. Referring to Figs. 6 and 7, intermediate shaft 140 includes a power input drive pulley  
27 144 adapted to engage a first toothed drive belt 158 that also engages a similar toothed drive  
28 pulley 127 provided at the output of transmission 36. Likewise, intermediate shaft 140 includes

1 a power output drive pulley 146 adapted to engage a second toothed drive belt 156 which also  
 2 engages a similar toothed drive pulley 138 provided on rear wheel 28 in substitution for rear  
 3 wheel drive gear 38 of Fig. 2. Within Fig. 7, dashed line 133 designates the central longitudinal  
 4 axis of the motorcycle support frame 26, while dashed line 135 designates the axis of rotation of  
 5 intermediate shaft 140. Also within Fig. 7, dashed line 137 represents the vertical plane in which  
 6 transmission output gear 127 and power input pulley 144 lie, while dashed line 139 represents  
 7 the vertical plane in which power output pulley 146 and rear wheel drive pulley 138 lie.

8 As mentioned above, motorcycle 20 may include a soft-tail rear suspension frame 30 that  
 9 is pivotally connected to central support frame 26. Shock absorbers (not shown) maintain rear  
 10 suspension frame 30 in proper nominal angular relationship relative to central support frame 26,  
 11 while permitting rear suspension frame 30 to pivot in response to bumps in the road. The details  
 12 of such rear suspension apparatus are set forth in greater detail in applicant's U.S. Patent No.  
 13 5,975,230, the disclosure of which is incorporated herein by reference. Ideally, the axle (see 60  
 14 in Fig. 3) that pivotally secures rear suspension frame 30 to central support frame 26 passes  
 15 through intermediate shaft 40, and hence the pivot axis about which the rear suspension frame 30  
 16 pivots is coincident with the axis of intermediate shaft 40. In this manner, the distance between  
 17 the transmission output gear (not shown) and the power input gear 44 always remains constant,  
 18 and the distance between power output gear 46 and rear wheel drive gear 38 always remains  
 19 constant, even though the rear wheel may be pivoting up and down due to bumps in the road.

20 Since intermediate shaft 40 serves to laterally translate the drive plane of the transmission  
 21 outwardly away from the central longitudinal axis of central support frame 26, motor 34 and  
 22 transmission 36 may be mounted to central support frame 26 in a manner which maintains the  
 23 motor's center of mass, and the transmission's center of mass, located along the central  
 24 longitudinal axis of central support frame 26. This improves the balance and handling of the  
 25 motorcycle, and enhances the rider's control over the motorcycle.

26 If the present invention is used with a motorcycle having a rigid rear frame (i.e., not a  
 27 soft-tail suspension), then adjustment screws can be added, if desired, for adjusting the distance  
 28 of the intermediate shaft 40 from transmission 36 in order to adjust the tension on drive chain 58

1 extending therebetween. Another adjustment mechanism may be provided near the axle of rear  
2 wheel 28 to allow for adjustment of the distance between intermediate shaft 40 and the axle of  
3 rear tire 28 in order to adjust the tension of drive chain 56 extending therebetween.

4 Those skilled in the art will now appreciate that an improved motorcycle has been  
5 described which easily and safely accommodates wide rear tires without the need to shift the  
6 center of mass of the motorcycle away from the centerline of the motorcycle frame. The  
7 motorcycle structure described above eliminates any requirement for laterally displacing the  
8 motor or transmission in order to accommodate a wide rear tire. Moreover, the intermediate  
9 shaft assembly described above works equally well with both motorcycles having a soft-tail  
10 suspension and those having a rigid tail end. While the present invention has been described  
11 with respect to a preferred embodiment thereof, such description is for illustrative purposes only,  
12 and is not to be construed as limiting the scope of the invention. Various modifications and  
13 changes may be made to the described embodiment by those skilled in the art without departing  
14 from the true spirit and scope of the invention as defined by the appended claims.

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